E. O. SCHLICK & M. WURL.

APPARATUS FOR MINIMIZING THE OSCILLATORY MOVEMENTS OF SHIPS AND OTHER OSCILLATING BODIES.

APPLICATION FILED MAR. 17, 1908.

944,511.

Patented Dec. 28, 1909.

2 SHEETS—SHEET 1.

Fig. 1.

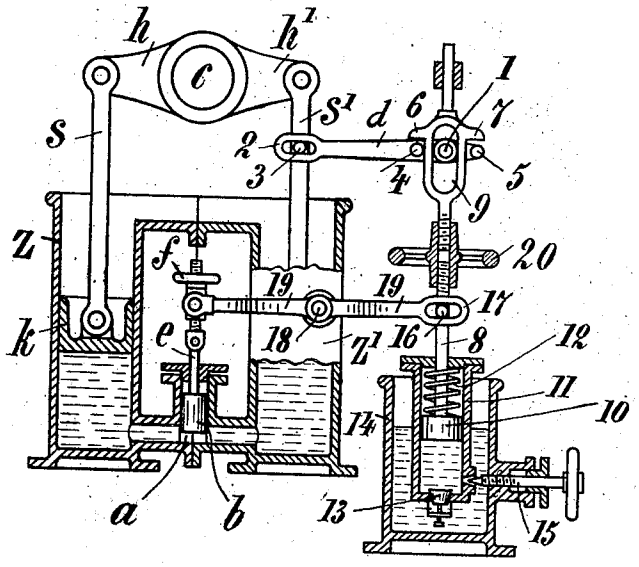
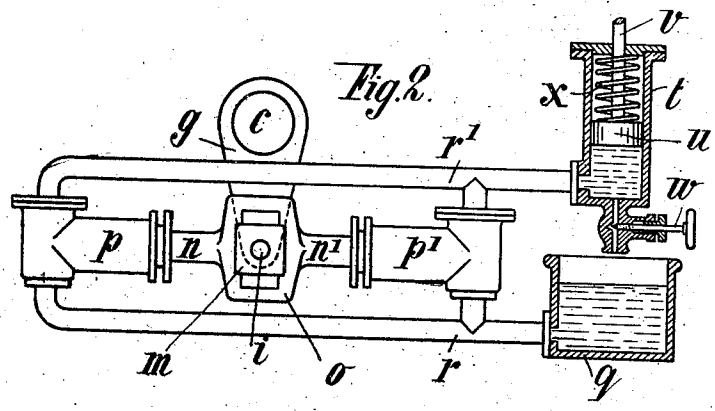


Fig. 2.



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2 SHEETS—SHEET 2.

Fig. 4.

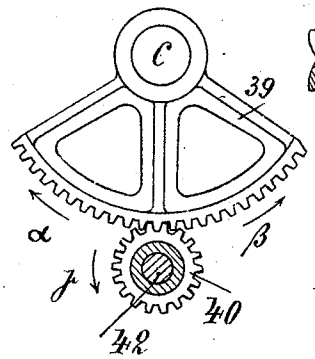


Fig. 3.

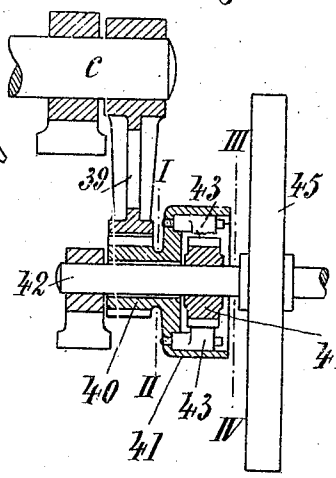


Fig. 5.

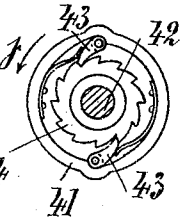


Fig. 6.

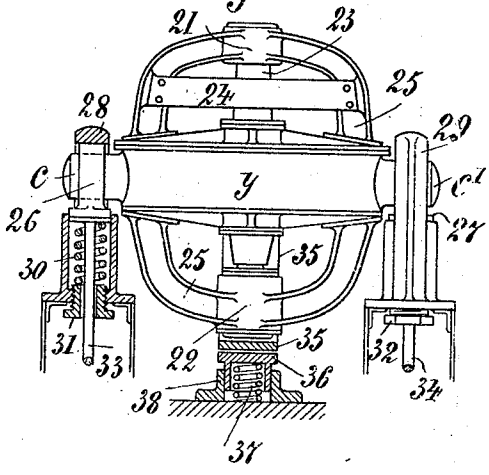
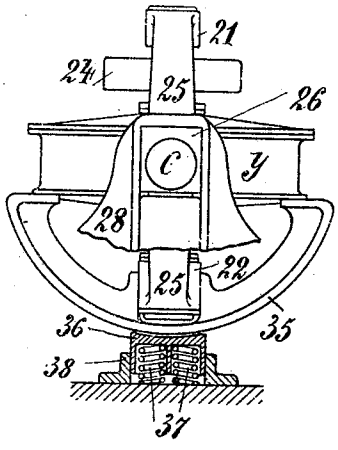


Fig. 7.



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR MINIMIZING THE OSCILLATORY MOVEMENTS OF SHIPS AND OTHER OSCILLATING BODIES.

944,511. Specification of Letters Patent. **Patented Dec. 28, 1909.**

Application filed March 17, 1908. Serial No. 421,668.

To all whom it may concern:

Be it known that we, ERNST OTTO SCHLICK, a subject of the German Emperor, and resident of Hamburg, Germany, and MAX WURL, a subject of the German Emperor, and resident of Newcastle-upon-Tyne, England, have invented certain new and useful Improvements in Apparatus for Minimizing the Oscillatory Movements of Ships and other Oscillating Bodies, of which the following is a specification.

This invention relates to apparatus, for minimizing the oscillatory movements of ships or other oscillating bodies, subjected to rolling or similar movements, of the type in which revolving bodies or fly wheels journaled in gimbal frames or supports are mounted in the ship, or other structure of which the movements are required to be controlled; the object being to provide means for regulating the braking effect automatically in accordance with the force of the waves (*a*) by influencing the strength of the braking by the amplitude of the oscillations of the revolving body or bodies (*b*) by influencing the strength of the braking by the angular velocity attained by the oscillations of the axle or axles of the revolving body or bodies (*c*) by regulating the strength of the braking by the couple incidental to the apparatus for preventing the rolling movement of the ship.

In a gyroscope with flywheel axle or shaft arranged vertically or horizontally, rocking movements of the said axle always arise during the rolling of the ship and their period should correspond as far as possible with the period of the roll of the ship in order to obtain as favorable an action as possible for preventing rolling movements. The amplitude of the rocking movement of the gyroscope axis depends mainly upon the magnitude of the forces exerted by the waves upon the ship to cause it to incline, or in other words the amplitude depends upon the size of the waves which the ship encounters. As is known, a braking device is therefore employed for maintaining a difference between the phases of the oscillations of the ship and the oscillations of the apparatus. The strength of the braking must, however, be regulated in accordance with the violence of the sea, in order to prevent the oscillation period from being too small, or in other words to prevent the gyroscope from effecting its oscillation too speedily and also in order to obviate an excessive amplitude of oscillation which might cause the aforesaid axle or shaft to assume an almost horizontal position, and likewise in order to maintain as far as possible a given difference of phase between the oscillations of the ship and those of the apparatus. As the waves never act regularly and uniformly upon the vessel or ship, experience has demonstrated that it is exceedingly difficult to regulate the strength of the braking by manual exertion, the result being generally unreliable.

For accomplishing the objects aimed at the present invention comprises braking mechanism whereby the regulation of the force of the braking of the oscillatory movements of the axles of the revolving bodies or fly wheels takes place automatically as the result of a regulating device adapted to be influenced by the amplitude of the oscillation of the said bodies; braking mechanism whereby the automatically acting regulating device is influenced by the magnitude of the angular velocity of the oscillation of the aforesaid bodies; and braking mechanism whereby the automatically acting regulating device is influenced by the magnitude of the couple produced by the body or bodies and serving for damping the rolling movements of the ship or vessel. The braking may be effected by means of hydraulic, pneumatic, electric or friction devices, but hydraulic or friction devices will in most cases be found desirable or satisfactory in employment.

In the accompanying sheets of drawings:—Figure 1 is a central section of a braking mechanism with an automatically acting device for regulating the force of the braking of the oscillatory movements of the axle of the fly wheel; the regulating device being influenced by the amplitude of the oscillation of the fly wheel; all constructed and arranged in accordance with and embodying my invention. Fig. 2 illustrates, partly in section, a modification of the automatically acting regulating device. Fig. 3 shows a central section of a further modification of the automatically acting regulat-

ing device adapted to be influenced by the magnitude of the angular velocity of the oscillation of the fly wheel. Fig. 4 is a sectional view according to the line I—II of Fig. 3 and Fig. 5 a similar view according to the line III—IV of Fig. 3. Fig. 6 is a front view, partly in section, seen in the longitudinal direction of the ship of a gyroscope-apparatus provided with a modified brake mechanism and also modified automatically acting regulating device, the latter adapted to be influenced by the magnitude of the couple produced by the fly wheel and serving for damping the rolling movements of the ship. Fig. 7 is a lateral or end view of Fig. 6, partly in section.

Similar letters and numerals of reference refer to like parts throughout the several figures.

Referring to Fig. 1, the strength of the braking may be regulated according to this invention by providing one of the lateral trunnions c of the gyroscope-apparatus (not shown) with lateral horizontal arms or levers h, h^1 adapted to carry pivoted rods s, s^1 the latter being respectively connected to pistons k working in cylinders z z^1 containing a quantity of water or other appropriate liquid. The cylinders are in communication by way of a passage a capable of regulation by a valve b so as to control the flow of liquid from the one cylinder to the other as the one or the other piston, as the case may be, is depressed during the working of the apparatus. The valve b may be of any suitable type and is adapted for automatic operation from another piston rod 8 which is in connection with one of the aforesaid piston rods s or s^1.

In the example shown, a horizontal arm or lever d pivoted at 1 is provided near its left end with a slot 2 engaging a pin 3 of the piston rod s^1. By the to-and-fro movements of the latter the arm d is rocked alternately up and down whereby suitable studs or projections 4 and 5 of the arm d engage alternately with corresponding tappets 6 and 7 of the piston rod 8 in order to lift the latter at each oscillation of the fly wheel accordingly. The piston rod 8 embracing the pivot or journal 1 of the arm d by means of a suitable slot 9 may be rendered adjustable in length by a screwed link 20 or the like. The piston 10 pertaining to the rod 8 and being under the action of a spring 12 is arranged in a cylinder 11 which is itself contained in a tank or receptacle 14 containing water or other appropriate liquid. The arrangement being such that, when the rod 8 is raised or lowered, as a result of the oscillatory movement of the aforesaid trunnion c, the piston 10 will act to permit water to flow into or escape from the cylinder 11, a valve 13 being provided at the lower end of the cylinder 11 for this purpose and another valve 15 being also provided for allowing of the escape of any excess of liquid. The spring 12 arranged in connection with the piston 10 and cylinder 11 assists the return of the piston. The water or other liquid in the apparatus serves to retard or make more difficult the movements of the parts.

The connection between the piston rod 8 and the valve stem e is effected by a double armed lever 19 pivoted at 18. The slotted end 17 of this lever engages a stud 16 of the piston rod 8, while the other end of the lever 19 is suitably attached to the valve stem e. The degree of opening the valve b may be rendered adjustable by means of a screw f or other suitable device.

According to the construction shown by Fig. 2 the trunnion c may carry a downwardly directed arm g which may be fitted to a stud i pertaining to a slide block m mounted in a slotted link o which connects two horizontal plunger pistons n and n^1 working in corresponding cylinders p and p^1. When the oscillations occur, water is pumped from a reservoir q through pipes r, r^1, into a cataract cylinder t so that the piston u therein and its rod v are forced upward. By means of an adjustable valve w, a certain quantity of water is permitted to flow from the cataract cylinder t to the said reservoir q, releasing the pressure beneath the piston u so that by means of a spring x the piston and rod may be pressed downward. The piston rod v then acts in a similar manner to that in the previously described construction, or in some other appropriate manner, on the regulating member pertaining to the brake cylinders, (for example on the valve b of Fig. 1), so that with an oscillation of the apparatus of large amplitude and consequently with a large stroke of the pump piston, the force of the braking by the braking member is increased.

For influencing the strength of the braking by the angular velocity attained by the oscillatory movement of the apparatus one of the trunnions c (Figs. 3–5) about which the apparatus rocks and which is mounted in a suitable bearing carries a toothed sector or quadrant 39 which engages with a spur wheel 40 ordinarily of smaller radius than the sector or quadrant. This spur wheel 40 may be formed or provided with a short cylindrical portion 41 and is mounted loosely upon a shaft 42 upon which is keyed a suitable fly wheel 45. The hollow portion 41 is provided interiorly with one, two or more pawls 43 adapted to engage a ratchet wheel 44 fast on the shaft 42. Upon the apparatus being subjected to an oscillatory motion and the quadrant 39 being consequently moved angularly the hollow cylinder 41 is also given a rotary movement according to the direction of the movement of the sector. When the cylinder or cup 41 is rotated in

the same direction as the hand of a clock (Fig. 5) the pawls 43 ride over the teeth of the ratchet wheel 44, but when the cup 41 is rotated in the direction of the arrow γ (Figs. 4 and 5) the pawls 43 engage the ratchet 44 and impart a rotary movement to it and consequently to the fly wheel 45 which is keyed on the same shaft as the ratchet.

When the amplitude of the oscillation of the apparatus is small, so that it passes through the middle position with only a small velocity, the flywheel 45 is only rotated slowly; when on the other hand the apparatus rocks very vigorously and widely, the flywheel 45 must assume a relatively high speed of rotation. This difference in the speed of rotation may be utilized for producing the braking action upon the regulating member. With this object either an appropriate centrifugal governor, a "Silver" marine governor or the like may be provided upon the shaft, or the shaft may be connected with a dynamo (not shown) the strength of the current of which then alters with the number of revolutions and acts appropriately upon the regulating member. The manner in which the fluctuations in the angular velocity of the oscillations on the apparatus are utilized so as to act upon the braking, may vary as desired.

In the construction shown by Figs. 3–5 the fly wheel 45 is acted upon only during the oscillatory movement of the quadrant 39 in the direction of the arrow α (Fig. 4). But if it be desired to act upon the fly wheel 45 during the oscillatory return movement of the quadrant 39 in the direction of the arrow β (Fig. 4), this may be accomplished by suitably arranging a second hollow portion 41 (not shown) adapted to operate a second ratchet by means of an intermediate wheel in the same direction as the first ratchet.

In order to avoid any risk of fracture of the teeth when employing toothed gearing, owing to a sudden rocking movement being imparted to the apparatus, a friction clutch may be provided, or instead of the toothed gearing, the periphery of the sector or quadrant and of the adjacent wheel may be formed for frictional engagement by constructing their contact surfaces of suitable character or material. Instead of the pawls, friction claws may be employed. If the mechanism herein referred to be made relatively strong and the fly wheel of appropriate weight it will be found that a direct damping action will be exerted upon the oscillatory movement of the gyroscope or apparatus and, in some cases, it will be found suitable for wholly or partly replacing the braking mechanism.

Referring to Figs. 6 and 7 showing a modified construction of our invention adapted to regulate the braking effect by the couple produced by the apparatus and preventing rolling movements of the ship, the fly wheel or rotating body may be inclosed in a drum or a similar envelop y in order to avoid the effect of air resistance. The frame 25 may be fitted with step bearings 21 and 22 for the shaft 23 of the fly wheel the rotating of which may be effected by means of an electric motor or other suitable mechanism contained in an appropriate support 24 attached to the frame 25. The trunnions c c^1 whereby the frame 25 and consequently the entire apparatus is supported and which constitute a horizontal axis of oscillation or the journals of the frame are mounted in bearings 26, 27 which are arranged within frames 28, 29 and yieldingly or elastically supported by means of adjustably mounted springs 30 or other convenient devices, in such a manner that they are capable of slight displacement in a downward direction. Helical springs 30 may be employed in this connection, the tension of the said springs being rendered adjustable by means of screws or nuts 31, 32.

Upon the couple being produced by the rocking of the apparatus about the trunnions c c^1 and tending to rotate the apparatus to the left, that is to say with respect to Fig. 7 against the direction of a watch-hand, the trunnion 26 will effect a slight depression of the bearing 26 and of the rod 33 or other connection connected with the said bearing; the displacement may be utilized for closing or opening in well known manner the valve or slide of a hydraulic brake cylinder or for restricting the cross section of a passage a (Fig. 1) such as hereinbefore referred to. Moreover, the aforesaid rod 33 may be adapted to act upon a cataract connected with the slide of the brake cylinder in the known manner. When the couple is produced by the rocking of the apparatus in the opposite direction, the bearing 27 will be depressed by the trunnion c^1 and the thereby displaced rod 34 act accordingly upon the regulating device of the brake mechanism.

Obviously, the trunnion bearings may be supported otherwise than by means of the aforesaid helical springs as, for instance, by hydraulic or pneumatic devices and it will be readily understood that the elastic or yielding bearings may also be rendered adjustable otherwise than by means of a screw nut. The hydraulic brake cylinders may also be dispensed with and be replaced by a friction brake (Figs. 6 and 7) which may comprise a hemispherical friction ring 35 attached to the gyroscope or apparatus and arranged in conjunction with a friction block 36 yieldingly mounted by means of springs 37 or equivalent devices in a suitable bearing cup 38. The strength of the spring pressure or of the elastic mounting may be rendered adjustable in any convenient manner. The action of this device is as follows:—When

owing to the couple produced, one of the trunnions moves downwardly so that the apparatus sinks slightly the aforesaid friction ring comes into contact with the friction block or surface thereby braking the oscillations of the apparatus. This presents the advantage that the couple produced by the apparatus can not exceed a certain amount and thus any strain is prevented from being put upon the parts. The friction ring may be arranged with its axis of rotation coinciding with that of the trunnions and may be constructed in any desired manner and of any desired or suitable material.

The above description relates principally to braking by means of hydraulic cylinders and the regulating members thereby required, and it would appear that hydraulic braking is preferable; any other methods and means of braking may however be employed for the mechanism in question; for example, pneumatic or electric braking, or frictional braking and also combinations of the same and appropriate regulating members.

We claim:

1. The combination with gyroscope mechanism and devices for damping the oscillations thereof; of means actuated from the gyroscope mechanism to regulate and control the damping effect during the oscillations.

2. The combination with gyroscope mechanism and devices for damping the oscillations thereof; of means actuated from the gyroscope mechanism to regulate the damping effect in accordance with the degree of amplitude of the oscillations.

3. The combination with gyroscope mechanism and hydraulic devices for damping the oscillations thereof; of means actuated from the gyroscope mechanism to control the action of said hydraulic mechanism.

4. The combination with a gyroscope mechanism and a cataract pump operatively connected thereto; of a valve mechanism controlled by the oscillation of the gyroscope to control the cataract.

5. The combination with a gyroscope mechanism; of a two-armed lever mounted on a trunnion thereof, a cataract pump comprising two cylinders and a by-pass connecting them, a piston in each cylinder and operatively connected to said lever, a valve to control said by-pass, and mechanism depending upon the amplitude of oscillation of the gyroscope to operate and control the valve.

6. The combination with gyroscope mechanism; of a cataract pump having a by-pass, said pump operated by the gyroscope, a valve in said by-pass and a valve controlling cataract mechanism dependent for its operation upon the oscillations of said gyroscope mechanism.

7. The combination with gyroscope mechanism; of a two-armed lever connected thereto, a cataract pump comprising two cylinders connected by a by-pass, pistons in said cylinders operatively connected to said lever, a valve in the by-pass, a single cataract cylinder, a receptacle around said cylinder, an inlet valve between said cylinder and receptacle, a vent for the cylinder into the receptacle, a loaded piston in said cylinder, a piston rod connected to the cylinder, a lever for actuating the rod and operatively connected to a moving element of the cataract pump, and a pivoted lever connected to the valve and to the piston rod.

Signed at Hamburg in the German Empire this 24th day of February 1908.

ERNST OTTO SCHLICK.

Witnesses:
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IDA HAFERMANN.

Signed at Newcastle-on-Tyne, England, this 27th day of February 1908.

MAX WURL.

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